

## **Polychlorinated Dibenzo-*p*-dioxins, Polychlorinated Dibenzofurans, and Coplanar Polychlorinated Biphenyls**

### *General Information*

Polychlorinated dibenzodioxins and dibenzofurans are two similar classes of chlorinated aromatic chemicals that usually are produced as contaminants or byproducts. They have no known commercial or natural use. Processes that contribute to their production include the incineration or burning of waste; pulp and bleaching processes used in pulp and paper mills; and the chemical syntheses of trichlorophenoxyacetic acid, hexachlorophene, polychlorinated biphenyls, vinyl chloride, and pentachlorophenol. As a result of man-made environmental release and contamination, most soil and water samples reveal trace amounts of polychlorinated dibenzodioxins and dibenzofurans when advanced analytical techniques are applied. Releases from industrial sources have decreased approximately 80% since the 1980s. The largest release of these chemicals today is the open burning of household trash and municipal trash, landfill fires, and agricultural and forest fires. In the environment, these chemicals usually occur as a mixture of congeners (i.e., compounds that differ by numbers and positions of chlorine atoms attached to the dibenzodioxin or dibenzofuran structures).

People are exposed primarily through foods that are contaminated with polychlorinated dibenzodioxins and dibenzofurans as a result of the accumulation of these substances in the food chain and in high-fat foods, such as dairy products, eggs, animal fats, and some fish. People have also been exposed through industrial accidents (e.g., an explosion in a factory in Seveso, Italy), use of accidentally contaminated cooking oils (e.g., as occurred in Yusho in Japan and Yu-cheng in Taiwan), spraying of herbicides contaminated with 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD, as Agent Orange in Vietnam), and burning of or exposure to polychlorinated biphenyls contaminated with polychlorinated dibenzofurans, such as in old electrical transformers. Workplace exposures are rare, and generally recognized standards for external exposure have not been established. Information about environmental levels and health effects is available online from ATSDR <http://www.atsdr.cdc.gov/toxprofiles>. The U.S. EPA

provides updated exposure and health assessments online at <http://www.epa.gov/ncea/pdfs/dioxin/>.

Effects in people have been observed as a result of industrial or accidental exposures involving large quantities of these chemicals. Chloracne, biochemical liver-test abnormalities, elevated blood lipids, fetal injury, and porphyria cutanea tarda have been reported in many of the studies. In some of these exposures, hormonal, neurologic, and immunologic effects have also been reported although with varying consistency (Michalek et al. 1999; Halperin et al., 1998; Jung et al., 1998, Matsuura et al., 2001). Congenital anomalies and intrauterine growth retardation were observed in offspring of mothers exposed to cooking oil contaminated with electrical oil containing polychlorinated biphenyls and dibenzofurans. Dioxins and polychlorinated biphenyls may possibly be associated with abnormal neurological status in newborns (Koopman-Esseboom et al., 1997).

Further, carcinogenic, genetic, reproductive, and developmental effects have been observed in many animal studies although species differ dramatically in sensitivity to these chemicals. The Institute of Medicine has determined that human epidemiologic evidence is sufficient for causally linking exposure to herbicide contaminated with TCDD to increased risk for non-Hodgkin's lymphoma, Hodgkin's lymphoma, and soft-tissue sarcoma (Institute of Medicine, 2000). Generally, the increased risk for these cancers occurs in association with large exposures encountered in contaminated occupational settings or massive unintentional releases.

Because general population exposure to these chemicals occurs as exposure to a mixture of different congeners, effects due to specific individual congeners are difficult to determine (Matsuda et al., 1997; Matsuda 2001). Clearly, however, many of the effects are mediated through an interaction with the aryl hydrocarbon receptor (AHR), particularly the induction of gene expression for cytochromes P450, CYP1A1, and CYP1A2. Dioxins and furans require three or four lateral chlorine atoms on the dibenzodioxin or dibenzofuran backbone to bind this receptor. The rank order of interaction with the AHR receptor by degree and position of chlorination is similar for both the dioxin and furan series. In addition, natural and endogenous substances may antagonize or add to the effects at this receptor. The variation in toxicity among the dioxins and furans and the effect at the AHR is

10,000-fold, with TCDD being the most potent. Because of its exceptional potency and because it is the most studied dioxin or furan, TCDD is separately classified by the IARC as a known human carcinogen (Group 1) and by NTP as a known human carcinogen. Other polychlorinated dibenzodioxins and dibenzofurans have not been studied sufficiently to determine their carcinogenicity (IARC).

Many of the other polychlorinated dibenzodioxins and dibenzofurans and certain polychlorinated biphenyls are less potent than TCDD but vary considerably in their respective concentrations. Each congener can be assigned a potency value relative to TCDD (toxic equivalency factor [TEF]). When a TEF is multiplied by the congener concentration level, a toxic equivalency (TEQ) value is obtained. Thus, the toxic contribution of the polychlorinated dibenzodioxins, dibenzofurans, and certain polychlorinated biphenyls can then be compared. The sum of all TEQs in a specimen (total TEQ) can be used to compare specimens. The coplanar polychlorinated biphenyls (unsubstituted at any ortho position, allowing a planar three-dimensional structure) and the mono-ortho-substituted polychlorinated biphenyls (a chlorine atom at one of the ortho positions) can also act through mechanisms thought to be similar to those described for the dioxins and furans. The coplanar-polychlorinated biphenyls have less potency, but their concentrations are often much higher than TCDD (Kang et al., 1997; Patterson et al., 1994), so their relative contribution to the total TEQ is potentially sizable. For a discussion of the other polychlorinated biphenyls, see the Polychlorinated Biphenyls section of this *Report*.

*Interpreting Lipid-Adjusted Serum Polychlorinated Dibenzo-p-dioxins, Polychlorinated Dibenzofurans, and Coplanar Polychlorinated Biphenyls Levels Reported in the Tables*

Serum lipid-based measurements of polychlorinated dibenzodioxins, dibenzofurans, and coplanar polychlorinated biphenyls were measured in a subsample of NHANES 1999-2000 participants aged 12 years and older. Subsamples were randomly selected within the specified age range to be a representative sample of the U.S. population. It is estimated that human serum lipid-based levels of polychlorinated dibenzodioxins and dibenzofurans have decreased by more than 80% since the 1980s (Aylward and Hays, 2002). The generally low

values reported here support that observation. Only the following polychlorinated dibenzodioxins, dibenzofurans and coplanar polychlorinated biphenyls (IUPAC nomenclature) had detection rates greater than 5% in the NHANES 1999-2000 subsample:

1,2,3,4,6,7,8,9-octachlorodibenzodioxin  
1,2,3,4,6,7,8-heptachlorodibenzodioxin  
1,2,3,6,7,8-hexachlorodibenzodioxin  
1,2,3,7,8,9-hexachlorodibenzodioxin  
1,2,3,7,8-pentachlorodibenzodioxin  
1,2,3,4,6,7,8-heptachlorodibenzofuran  
1,2,3,4,7,8-hexachlorodibenzofuran  
1,2,3,6,7,8-hexachlorodibenzofuran  
2,3,4,7,8-pentachlorodibenzofuran  
coplanar polychlorinated biphenyls 169 and 126.

In addition, mono-ortho substituted PCBs 118 and 156 also had detection rates above 5% (discussed in the section titled “Polychlorinated Biphenyls” below).

In keeping with results from other reports (Papke et al., 1998), this NHANES 1999-2000 subsample shows that the the more highly chlorinated dioxin and furan congeners, several coplanar chlorinated polychlorinated biphenyls (listed above), and some of the mono-ortho substituted polychlorinated biphenyls (see Polychlorinated Biphenyl section) are the main contributors to the human body burden and total TEQ. Higher concentrations of these congeners are due to their greater presence in the food chain, resistance to metabolic degradation, and greater solubility in body fat. For example, people consuming fish from the Great Lakes have had modestly increased mean concentrations of dioxins and furans that are several times the population background values (Falk et al., 1999; Anderson et al., 1998; Hanrahan et al., 1999). The patterns of individual congeners in a specimen when present at high concentrations can represent the exposure source in some cases, but are less predictive at low levels due to mixing of many low-level sources before ingestion and the differential effect of elimination on different congeners from the body.

Differences in levels of polychlorinated dibenzodioxins, dibenzofurans, and coplanar polychlorinated biphenyls that are present in serum are due in part to exposure but also result from differences in absorption, tissue distribution, metabolism, and elimination. Half-lives for all the dioxins and furans vary from 3-19 years, with TCDD

estimated at around 7 years (Geyer et al., 2002). The more highly chlorinated congeners are retained longer and accumulate more in the body. Because these chemicals are stored in adipose tissue, they will have longer residence times in people with higher amounts of body fat (Tepper et al. 1997). Current levels may be influenced by both past (fat-stored chemicals) and recent exposures. Several studies have shown that the serum levels of dioxins and furans increase with the age of the individual (Falk et al., 1999). In this *Report*, 1,2,3,4,6,7,8,9-octachlorodibenzodioxin, 1,2,3,4,6,7,8-heptachlorodibenzodioxin and 1,2,3,6,7,8-hexachlorodibenzodioxin levels were higher in the 20 years and older group than in the 12-19-year-old group when compared at the higher percentiles.

The most potent of the polychlorinated dibenzodioxins, dibenzofurans, and coplanar polychlorinated biphenyls is 2,3,7,8-tetrachlorodibenzodioxin. In the current NHANES 1999-2000 subsample, the rate of detection was 0.7%. The LOD varied because of available speci-

men volumes. The average LOD was 4.8 picograms/gram (pg/gram) of lipid (standard deviation [SD] 2.0 pg/gram lipid). Background levels in the United States and other developed countries have fallen to levels near or below these LODs (Papke et al., 1998; Calvert et al., 1996). These levels are much lower than those for chemical-production workers when they were examined 15 years after workplace exposure had ceased (median serum TCDD concentration = 68 pg/gram lipid) (Calvert et al., 1996). The level of TCDD in the fat and serum is also known to increase with age of the individual (Luotamo et al., 1991).

Levels in this *Report* are far below those associated with the occupational and unintentional exposures that produced health effects. There are no firmly established relationships between serum lipid-based concentrations and effects in people. Studies of industrial and accidental exposures suggest that concentrations of at least 800 pg/gram lipid might be necessary to induce chloracne, a specific effect, although levels in the thousands of

**Table 76. Polychlorinated dibenzo-*p*-dioxins, polychlorinated dibenzofurans, and coplanar polychlorinated biphenyls**

| <b>Polychlorinated dibenzo-<i>p</i>-dioxins</b>            | <b>CAS number</b> |                     |
|--|-------------------|---------------------|
| 1,2,3,4,6,7,8,9-Octachlorodibenzo- <i>p</i> -dioxin (OCDD) | 3268-87-9         |                     |
| 1,2,3,4,6,7,8-Heptachlorodibenzo- <i>p</i> -dioxin (HpCDD) | 35822-46-9        |                     |
| 1,2,3,6,7,8-Hexachlorodibenzo- <i>p</i> -dioxin (HxCDD)    | 57653-85-7        |                     |
| 1,2,3,7,8,9-Hexachlorodibenzo- <i>p</i> -dioxin (HxCDD)    | 19408-74-3        |                     |
| 1,2,3,7,8-Pentachlorodibenzo- <i>p</i> -dioxin (PeCDD)     | 40321-76-4        |                     |
| 2,3,7,8-Tetrachlorodibenzo- <i>p</i> -dioxin (TCDD)        | 1746-01-6         |                     |
| <b>Polychlorinated dibenzofurans</b>                       | <b>CAS number</b> |                     |
| 1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)              | 39001-02-0        |                     |
| 1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)              | 67562-39-4        |                     |
| 1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)                 | 70648-26-9        |                     |
| 1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)                 | 57117-44-9        |                     |
| 1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)                 | 72918-21-9        |                     |
| 1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)                  | 57117-41-6        |                     |
| 2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)                 | 60851-34-5        |                     |
| 2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)                  | 57117-31-4        |                     |
| 2,3,7,8-Tetrachlorodibenzofuran (TCDF)                     | 51207-31-9        |                     |
| <b>Polychlorinated biphenyls (coplanar)</b>                | <b>CAS number</b> | <b>IUPAC number</b> |
| 3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)                | 32774-16-6        | PCB 169             |
| 3,3',4,4',5-Pentachlorobiphenyl (PCB 126)                  | 57465-28-8        | PCB 126             |
| 3,4,4',5-Tetrachlorobiphenyl (PCB 81)                      | 70362-50-4        | PCB 81              |

pg/gram lipid do not always produce this effect (Mocarelli et al., 1991). The few studies showing effects in people after large unintentional exposures have demonstrated concentrations ranging from several hundred to the tens of thousands of pg/gram lipid (Masuda 2001; Masuda et al., 1998; Mocarelli et al., 1991).

Finding a measurable amount of one or more of the polychlorinated dibenzodioxins, dibenzofurans, or coplanar biphenyls in serum does not mean that the level of one or more of these causes an adverse health effect. Whether the concentrations reported here are a cause for health concern is not yet known; more research is needed. These levels provide physicians with a reference range so that they can determine whether people have been exposed to higher levels of polychlorinated dibenzodioxins, dibenzofurans, or coplanar biphenyls than those found in the general population. These data will also help scientists plan and conduct research on exposure and health effects.

Measuring polychlorinated dibenzodioxins, dibenzofurans, or coplanar biphenyls at these levels in serum is possible because of advances in analytical chemistry. As seen in other recent population studies, pooling of approximately 50 or more specimens is required to have adequate amounts of sample to detect the general population levels of dioxin-like compounds that are needed to properly estimate a TEQ. Because of limited availability of serum volumes and the low levels detected in the NHANES 1999-2000 population, TEQ values are not estimated from this analysis of individual samples. Future plans for the *Report* include the analysis of pooled samples to significantly lower the LOD for these compounds and allow calculation of TEQ values.

**Table 77. 1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. interval) | Selected percentiles<br>(95% confidence interval) |       |       |                  |                  |                    | Sample size |
|--------------------------------|--|---|-------|-------|------------------|------------------|--------------------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th             | 90th             | 95th               |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | 405<br>(369-446) | 674<br>(598-741) | 913<br>(806-986)   | 1921        |
| <b>Age group</b>               |  |   |       |       |                  |                  |                    |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD            | < LOD            | 421<br>(<LOD-597)  | 667         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | 445<br>(403-484) | 704<br>(625-800) | 948<br>(846-1030)  | 1254        |
| <b>Gender</b>                  |  |   |       |       |                  |                  |                    |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD            | 515<br>(449-580) | 704<br>(579-806)   | 919         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | 503<br>(446-538) | 802<br>(689-927) | 1010<br>(948-1130) | 1002        |
| <b>Race/ethnicity</b>          |  |   |       |       |                  |                  |                    |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | 416<br>(367-496) | 702<br>(582-916) | 940<br>(737-1280)  | 632         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | 444<br>(380-497) | 741<br>(594-904) | 1120<br>(799-1560) | 411         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | 390<br>(345-443) | 625<br>(569-727) | 848<br>(731-982)   | 721         |

< LOD means less than the limit of detection, which averaged 145 pg/g of lipid (SD 46.0, maximum value 329).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 78. 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |                     |                     |                     | Sample size |
|--------------------------------|--|---|-------|-------|---------------------|---------------------|---------------------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th                | 90th                | 95th                |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | 58.2<br>(<LOD-63.3) | 85.6<br>(75.1-97.0) | 112<br>(102-128)    | 1894        |
| <b>Age group</b>               |  |   |       |       |                     |                     |                     |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD               | < LOD               | 63.6<br>(<LOD-72.3) | 657         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | 61.9<br>(56.7-66.9) | 92.0<br>(80.8-102)  | 119<br>(103-132)    | 1237        |
| <b>Gender</b>                  |  |   |       |       |                     |                     |                     |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD               | 73.6<br>(68.7-83.1) | 94.7<br>(81.7-103)  | 910         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | 62.6<br>(<LOD-68.5) | 102<br>(86.0-118)   | 129<br>(118-155)    | 984         |
| <b>Race/ethnicity</b>          |  |   |       |       |                     |                     |                     |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | 61.2<br>(<LOD-69.0) | 97.7<br>(81.2-112)  | 132<br>(105-164)    | 621         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | 58.1<br>(<LOD-67.7) | 95.0<br>(72.8-110)  | 125<br>(101-183)    | 408         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | 58.9<br>(<LOD-64.5) | 84.9<br>(72.0-97.0) | 106<br>(96.7-121)   | 709         |

< LOD means less than the limit of detection, which averaged 24.7 pg/g of lipid (SD 7.8, maximum value 55.9).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 79. 1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin (HxCDD) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |                     |                     |                     | Sample size |
|--------------------------------|--|---|-------|-------|---------------------|---------------------|---------------------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th                | 90th                | 95th                |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | 32.6<br>(29.2-36.6) | 56.7<br>(51.0-64.4) | 74.0<br>(69.1-79.4) | 1885        |
| <b>Age group</b>               |  |   |       |       |                     |                     |                     |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD               | < LOD               | 26.7<br>(20.3-29.3) | 648         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | 36.1<br>(32.5-39.8) | 62.8<br>(55.0-68.3) | 75.6<br>(71.1-82.8) | 1237        |
| <b>Gender</b>                  |  |   |       |       |                     |                     |                     |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | 31.5<br>(25.7-35.6) | 54.8<br>(47.0-62.8) | 71.1<br>(63.8-77.7) | 908         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | 34.9<br>(29.3-39.4) | 61.2<br>(51.9-68.3) | 74.9<br>(69.2-90.4) | 977         |
| <b>Race/ethnicity</b>          |  |   |       |       |                     |                     |                     |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | 20.9<br>(<LOD-25.0) | 43.3<br>(33.9-52.6) | 58.0<br>(49.5-64.8) | 624         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | 31.8<br>(26.6-40.9) | 56.7<br>(45.2-72.4) | 81.6<br>(66.2-94.1) | 402         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | 35.5<br>(30.7-39.4) | 60.9<br>(53.6-67.7) | 74.3<br>(68.4-82.4) | 703         |

< LOD means less than the limit of detection, which averaged 7.5 pg/g of lipid (SD 3.1, maximum value 20.1).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 80. 1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin (HxCDD) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |       |       | Sample size |
|--------------------------------|--|---|-------|-------|-------|-------|-------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th  | 95th  |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1870        |
| <b>Age group</b>               |  |   |       |       |       |       |       |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 642         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1228        |
| <b>Gender</b>                  |  |   |       |       |       |       |       |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 895         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 975         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |       |       |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 618         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 396         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 701         |

< LOD means less than the limit of detection, which averaged 7.6 pg/g of lipid (SD 3.2, maximum value 20.3).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 81. 1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin (PeCDD) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |       |       | Sample size |
|--------------------------------|--|---|-------|-------|-------|-------|-------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th  | 95th  |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1915        |
| <b>Age group</b>               |  |   |       |       |       |       |       |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 659         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1256        |
| <b>Gender</b>                  |  |   |       |       |       |       |       |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 920         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 995         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |       |       |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 632         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 408         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 717         |

< LOD means less than the limit of detection, which averaged 5.3 pg/g of lipid (SD 2.2, maximum value 14.2).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 82. 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |       |       | Sample size |
|--------------------------------|--|---|-------|-------|-------|-------|-------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th  | 95th  |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1898        |
| <b>Age group</b>               |  |   |       |       |       |       |       |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 658         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1240        |
| <b>Gender</b>                  |  |   |       |       |       |       |       |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 912         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 986         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |       |       |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 630         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 404         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 709         |

< LOD means less than the limit of detection, which averaged 4.8 pg/g of lipid (SD 1.8, maximum value 12.1).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 83. 1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |       |       | Sample size |
|--------------------------------|--|---|-------|-------|-------|-------|-------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th  | 95th  |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1884        |
| <b>Age group</b>               |  |   |       |       |       |       |       |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 652         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1232        |
| <b>Gender</b>                  |  |   |       |       |       |       |       |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 904         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 980         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |       |       |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 623         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 404         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 705         |

< LOD means less than the limit of detection, which averaged 12.6 pg/g of lipid (SD 5.7, maximum value 35.6).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 84. 1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |                     |                     | Sample size |
|--------------------------------|--|---|-------|-------|-------|---------------------|---------------------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th                | 95th                |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | 14.7<br>(<LOD-17.0) | 19.5<br>(17.4-22.3) | 1709        |
| <b>Age group</b>               |  |   |       |       |       |                     |                     |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | 17.7<br>(<LOD-22.9) | 24.0<br>(18.6-29.6) | 600         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | 14.2<br>(<LOD-16.4) | 18.4<br>(16.0-22.4) | 1109        |
| <b>Gender</b>                  |  |   |       |       |       |                     |                     |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | 16.3<br>(13.9-18.5) | 21.0<br>(18.5-24.7) | 815         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | 17.5<br>(14.8-19.7) | 894         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |                     |                     |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | 19.7<br>(<LOD-26.0) | 570         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | 22.4<br>(15.3-28.2) | 28.2<br>(23.8-29.8) | 359         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | 17.4<br>(15.5-18.5) | 636         |

< LOD means less than the limit of detection, which averaged 5.2 pg/g of lipid (SD 2.1, maximum value 13.5).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 85. 1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |       |                     | Sample size |
|--------------------------------|--|---|-------|-------|-------|-------|---------------------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th  | 95th                |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD               | 1890        |
| <b>Age group</b>               |  |   |       |       |       |       |                     |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD               | 657         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD               | 1233        |
| <b>Gender</b>                  |  |   |       |       |       |       |                     |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD               | 908         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | 12.9<br>(<LOD-14.7) | 982         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |       |                     |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD               | 631         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | 14.3<br>(<LOD-15.1) | 399         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD               | 703         |

< LOD means less than the limit of detection, which averaged 4.7 pg/g of lipid (SD 2.0, maximum value 12.7).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 86. 1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |       |       | Sample size |
|--------------------------------|--|---|-------|-------|-------|-------|-------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th  | 95th  |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1898        |
| <b>Age group</b>               |  |   |       |       |       |       |       |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 656         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1242        |
| <b>Gender</b>                  |  |   |       |       |       |       |       |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 913         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 985         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |       |       |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 625         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 408         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 708         |

< LOD means less than the limit of detection, which averaged 4.8 pg/g of lipid (SD 2.0, maximum value 12.6).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 87. 1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |       |       | Sample size |
|--------------------------------|--|---|-------|-------|-------|-------|-------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th  | 95th  |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1875        |
| <b>Age group</b>               |  |   |       |       |       |       |       |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 645         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1230        |
| <b>Gender</b>                  |  |   |       |       |       |       |       |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 894         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 981         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |       |       |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 620         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 400         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 699         |

< LOD means less than the limit of detection, which averaged 4.6 pg/g of lipid (SD 2.0, maximum value 12.7).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 88. 1,2,3,7,8-Pentachlorodibenzofuran (PeCDF) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |       |       | Sample size |
|--------------------------------|--|---|-------|-------|-------|-------|-------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th  | 95th  |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1922        |
| <b>Age group</b>               |  |   |       |       |       |       |       |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 663         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1259        |
| <b>Gender</b>                  |  |   |       |       |       |       |       |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 920         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1002        |
| <b>Race/ethnicity</b>          |  |   |       |       |       |       |       |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 637         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 409         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 717         |

< LOD means less than the limit of detection, which averaged 5.0 pg/g of lipid (SD 2.1, maximum value 13.2).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 89. 2,3,4,6,7,8,-Hexachlorodibenzofuran (HxCDF) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |       |       | Sample size |
|--------------------------------|--|---|-------|-------|-------|-------|-------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th  | 95th  |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1884        |
| <b>Age group</b>               |  |   |       |       |       |       |       |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 652         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1232        |
| <b>Gender</b>                  |  |   |       |       |       |       |       |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 900         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 984         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |       |       |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 614         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 408         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 704         |

< LOD means less than the limit of detection, which averaged 4.8 pg/g of lipid (SD 2.0, maximum value 12.9).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 90. 2,3,4,7,8-Pentachlorodibenzofuran (PeCDF) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |                     |                     | Sample size |
|--------------------------------|--|---|-------|-------|-------|---------------------|---------------------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th                | 95th                |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | 15.9<br>(13.8-17.0) | 1895        |
| <b>Age group</b>               |  |   |       |       |       |                     |                     |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | < LOD               | 656         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | 16.1<br>(13.9-17.2) | 1239        |
| <b>Gender</b>                  |  |   |       |       |       |                     |                     |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | 13.8<br>(<LOD-15.4) | 906         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | 13.1<br>(<LOD-15.5) | 16.7<br>(15.5-18.4) | 989         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |                     |                     |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | < LOD               | 632         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | 16.3<br>(13.2-19.2) | 400         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | 15.5<br>(13.7-17.1) | 706         |

< LOD means less than the limit of detection, which averaged 4.8 pg/g of lipid (SD 2.0, maximum value 12.7).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 91. 2,3,7,8-Tetrachlorodibenzofuran (TCDF) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |       |       | Sample size |
|--------------------------------|--|---|-------|-------|-------|-------|-------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th  | 95th  |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1903        |
| <b>Age group</b>               |  |   |       |       |       |       |       |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 660         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1243        |
| <b>Gender</b>                  |  |   |       |       |       |       |       |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 912         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 991         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |       |       |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 628         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 409         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 707         |

< LOD means less than the limit of detection, which averaged 4.6 pg/g of lipid (SD 1.8, maximum value 11.9).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 92. 3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |                     |                     | Sample size |
|--------------------------------|--|---|-------|-------|-------|---------------------|---------------------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th                | 95th                |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | 34.3<br>(31.9-37.5) | 44.5<br>(40.3-49.1) | 1888        |
| <b>Age group</b>               |  |   |       |       |       |                     |                     |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | < LOD               | 648         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | 36.4<br>(34.0-40.0) | 47.8<br>(42.5-51.2) | 1240        |
| <b>Gender</b>                  |  |   |       |       |       |                     |                     |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | 36.2<br>(32.8-40.0) | 44.3<br>(40.0-49.6) | 908         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | 34.0<br>(29.8-38.0) | 46.5<br>(38.6-51.1) | 980         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |                     |                     |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD               | 31.0<br>(28.1-35.6) | 622         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | 40.3<br>(30.8-47.3) | 51.1<br>(42.6-63.9) | 403         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | 34.6<br>(32.4-38.7) | 45.3<br>(40.3-50.9) | 709         |

< LOD means less than the limit of detection, which averaged 9.9 pg/g of lipid (SD 4.3, maximum value 27.0).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 93. 3,3',4,4',5-Pentachlorobiphenyl (PCB 126) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |                     |                     |                     | Sample size |
|--------------------------------|--|---|-------|-------|---------------------|---------------------|---------------------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th                | 90th                | 95th                |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | 28.5<br>(25.9-31.5) | 53.2<br>(46.8-59.1) | 80.5<br>(65.0-98.6) | 1896        |
| <b>Age group</b>               |  |   |       |       |                     |                     |                     |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD               | 23.8<br>(<LOD-27.5) | 30.6<br>(23.8-38.6) | 658         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | 30.8<br>(27.8-34.9) | 57.1<br>(50.6-65.5) | 89.5<br>(68.3-104)  | 1238        |
| <b>Gender</b>                  |  |   |       |       |                     |                     |                     |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | 25.4<br>(<LOD-28.6) | 41.6<br>(34.8-47.9) | 61.9<br>(47.9-79.2) | 911         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | 33.3<br>(28.3-38.9) | 59.4<br>(53.6-75.1) | 96.7<br>(75.9-110)  | 985         |
| <b>Race/ethnicity</b>          |  |   |       |       |                     |                     |                     |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | 23.8<br>(<LOD-29.0) | 42.7<br>(37.6-51.8) | 66.1<br>(54.8-74.0) | 631         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | 30.3<br>(25.8-41.4) | 67.4<br>(48.9-104)  | 120<br>(75.1-203)   | 404         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | 28.3<br>(23.5-31.9) | 50.4<br>(41.6-56.6) | 67.8<br>(57.1-94.1) | 704         |

< LOD means less than the limit of detection, which averaged 9.0 pg/g of lipid (SD 3.6, maximum value 23.2).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.

**Table 94. 3,4,4',5-Tetrachlorobiphenyl (PCB 81) (lipid adjusted)**

Geometric mean and selected percentiles of serum concentrations (picograms/gram [pg/g] of lipid or parts-per-trillion on a lipid weight basis) for the U.S. population aged 12 years and older, National Health and Nutrition Examination Survey, 1999-2000.

|                                | Geometric mean<br>(95% conf. Interval) | Selected percentiles<br>(95% confidence interval) |       |       |       |       |       | Sample size |
|--------------------------------|--|---|-------|-------|-------|-------|-------|-------------|
|                                |  | 10th  | 25th  | 50th  | 75th  | 90th  | 95th  |             |
| <b>Total, age 12 and older</b> | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1883        |
| <b>Age group</b>               |  |   |       |       |       |       |       |             |
| 12-19 years                    | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 651         |
| 20 years and older             | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 1232        |
| <b>Gender</b>                  |  |   |       |       |       |       |       |             |
| Males                          | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 900         |
| Females                        | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 983         |
| <b>Race/ethnicity</b>          |  |   |       |       |       |       |       |             |
| Mexican Americans              | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 621         |
| Non-Hispanic blacks            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 405         |
| Non-Hispanic whites            | *                                      | < LOD   | < LOD | < LOD | < LOD | < LOD | < LOD | 699         |

< LOD means less than the limit of detection, which averaged 25.8 pg/g of lipid (SD 10.7, maximum value 68.4).

\* Not calculated. Proportion of results below limit of detection was too high to provide a valid result.